CHAPTER 39

Auscultation of the Heart: General Principles

KEY TEACHING POINTS

- Careful auscultation of the heart requires a quiet examination room and a systematic approach from the clinician, inching the stethoscope from apex to base (or in the opposite direction, from base to apex) and at each location focusing on each element of the cardiac cycle (i.e., S_1, S_2, systole, and diastole).
- The bell of the stethoscope is used to identify low-frequency sounds; the diaphragm is used to listen to high-frequency sounds.
- The best way to distinguish systole from diastole is by the cadence of heart tones (systole is shorter than diastole if the heart rate is normal) or by identifying S_2 at the second left parasternal space, where it is the louder, snappier heart sound.

I. CHARACTERISTICS OF HEART SOUNDS AND MURMURS

Different heart sounds and murmurs are distinguished by four characteristics: (1) timing (i.e., systolic or diastolic), (2) intensity (i.e., loud or soft), (3) duration (i.e., long or short), and (4) pitch (i.e., low or high frequency). A fifth characteristic, the sound's quality, is also sometimes included in descriptions of sounds (e.g., it may be described as "musical," a "whoop," or a "honk"). Almost all heart sounds contain a mixture of frequencies (i.e., they are not musical in the acoustical sense, but instead are "noise," like the static of a radio tuned between stations). Therefore the descriptors *low frequency* and *high frequency* do not indicate that a sound has a pure musical tone of a certain low or high pitch but instead that the bulk of the sound's energy is within the low or high range.

Although the human ear can hear sounds with frequencies from 20 to 20,000 cycles per second (Hz), the principal frequencies of heart sounds and murmurs are at the lower end of this range, from 20 to 500 Hz.[1,2] Therefore **low-frequency sounds** are those whose dominant frequencies are less than 100 Hz, such as third and fourth heart sounds and the diastolic murmur of mitral stenosis. These sounds are usually difficult to hear because the human ear perceives lower frequencies relatively less well than higher frequencies. The murmur containing the highest frequency sound is aortic regurgitation, whose dominant frequencies are approximately 400 Hz. The principal frequencies of other sounds and murmurs are between 100 and 400 Hz.

II. THE STETHOSCOPE

A. BELL AND DIAPHRAGM

The stethoscope has two different heads to receive sound, the bell and the diaphragm. The bell is used to detect low-frequency sounds and the diaphragm to detect high-frequency sounds.

The traditional explanation that the bell selectively transmits low-frequency sounds and the diaphragm selectively filters out low-frequency sounds is probably incorrect. Actually, the bell transmits all frequencies well, but in some patients with high-frequency murmurs (e.g., aortic regurgitation), any additional low-frequency sound masks the high-frequency sound and makes the murmur difficult to detect.[3] The diaphragm does not selectively filter out low-frequency sounds but instead attenuates all frequencies equally, thus dropping the barely audible low-frequency ones below the threshold of human hearing.[3]

B. PERFORMANCE OF DIFFERENT STETHOSCOPE MODELS

Many studies have examined the acoustics of stethoscopes, but the clinical relevance of this research has never been formally tested. In general, these studies show that shallow bells transmit sound as well as deeper bells and that double tube stethoscopes are equivalent to single tube models.[3] The optimal internal bore of a stethoscope is somewhere between one-eighth and three-sixteenths of an inch because smaller bores diminish transmission of the higher frequency sounds.[1,4,5] Compared with shorter lengths of stethoscope tubing, longer tubes also impair the conduction of high-frequency sounds.[1]

However, most modern stethoscopes transmit sound equally well, the differences among various models for single frequencies being very small.[3] The most important source of poor acoustic performance is an air leak, which typically results from poorly fitting ear pieces. Even a tiny air leak with a diameter of only 0.015 inch will diminish transmission of sound by as much as 20 dB,* particularly for those sounds less than 100 Hz.[6]

III. USE OF THE STETHOSCOPE

Between the 1950s and late 1970s, cardiac auscultation was at its peak.† During this time cardiologists perfected their skills by routinely comparing the bedside findings to the patient's phonocardiogram, angiogram, and surgical findings, which allowed clinicians to make precise and accurate diagnoses from bedside findings alone. The principles of bedside diagnosis used by these clinicians are included elsewhere in this book. How these clinicians specifically used the stethoscope to examine the patient is presented below.

A. EXAMINATION ROOM

Many faint heart sounds and murmurs are inaudible unless there is complete silence in the room. The clinician should close the door to the examination room, turn off the television and radio, and ask that all conversation stop.

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* *Decibels* describe relative intensity (or loudness) on a logarithmic scale.

† In the late 1970s two events initiated the decline of cardiac auscultation: the widespread introduction of echocardiography and the decision by insurance companies to no longer make reimbursements for phonocardiography.

B. BELL PRESSURE

To detect low-frequency sounds, the stethoscope bell should be applied to the body wall with only enough pressure to create an air seal and exclude ambient noise. Excessive pressure with the bell stretches the skin, which then acts like a diaphragm and makes low-frequency sounds more difficult to hear. By selectively varying the pressure on the stethoscope bell, the clinician can easily distinguish low- from high-frequency sounds: if a sound is audible with the bell using light pressure but disappears with firm pressure, it is a low-frequency sound. This technique is frequently used to confirm that an early diastolic sound is indeed a third heart sound (i.e., third heart sounds are low-frequency sounds, whereas other early diastolic sounds like the pericardial knock are high-frequency sounds) and to distinguish the combined fourth and first heart sounds (S_4–S_1) from the split S_1 (the S_4 is a low-frequency sound but the S_1 is not; firm pressure renders the S_4–S_1 into a single sound but does not affect the double sound of the split S_1).

C. PATIENT POSITION

The clinician should listen to the patient's heart with the patient in three positions: supine, left lateral decubitus, and seated upright. The lateral decubitus position is best for detection of the third and fourth heart sounds and the diastolic murmur of mitral stenosis (to detect these sounds, the clinician places the bell lightly over the apical impulse or just medial to the apical impulse).[7] The seated upright position is necessary to further evaluate audible expiratory splitting of S_2 (see Chapter 40) and to detect some pericardial rubs and murmurs of aortic regurgitation (see Chapters 45 and 47).

D. ORDER OF EXAMINATION

Routine auscultation of the heart should include the right upper sternal area, the entire left sternal border, and the apex. Some cardiologists recommend proceeding from base to apex;[2] others from apex to base.[8] The diaphragm of the stethoscope should be applied to all areas, especially at the upper left sternal area to detect S_2 splitting and at all areas to detect other murmurs and sounds. After using the diaphragm to listen to the lower left sternal area and apex, the bell should also be applied to these areas to detect diastolic filling sounds (S_3 and S_4) and diastolic rumbling murmurs (e.g., mitral stenosis).

In selected patients the clinician should also listen over the carotid arteries and axilla (in patients with systolic murmurs, to clarify radiation of murmur), the lower right sternal area (in patients with diastolic murmur of aortic regurgitation, to detect aortic root disease), the back (in young patients with hypertension, to detect the continuous murmur of coarctation), or other thoracic sites (in patients with central cyanosis, to detect the continuous murmur of pulmonary arteriovenous fistulas).

E. DESCRIBING THE LOCATION OF SOUNDS

When describing heart sounds and murmurs, the clinician should identify where on the chest wall the sound is loudest. Traditionally the second right intercostal space next to the sternum is called the *aortic area* or *right base*; the second left intercostal space next to the sternum, the *pulmonary area* or *left base*; the fourth or fifth left parasternal space, the *tricuspid area* or *left lower sternal border*; and the most lateral point of the palpable cardiac impulse, the *mitral area* or *apex* (see Fig. 38.1 in Chapter 38).

However, the terms *aortic area*, *pulmonary area*, *tricuspid area*, and *mitral area* are ambiguous and are best avoided. Many patients with aortic stenosis have murmurs loudest in the mitral area, and some with mitral regurgitation have murmurs in the

pulmonary or aortic area. A more precise way to describe the location of sounds is to use the apex and the parasternal areas as reference points, the parasternal location being further specified by the intercostal space (first, second, or third intercostal space; or lower sternal border) and whether it is the right or left edge of the sternum. For example, a sound might be loudest at the "apex," the "second left intercostal space" (i.e., next to the left sternal edge in the second intercostal space), or "between the apex and left lower sternal border."

F. TECHNIQUE OF FOCUSING

The human brain has an uncanny ability to isolate and focus on one type of sensory information, by repressing awareness of all other sensations. A common example of this phenomenon is the person reading a book in a room in which a clock is ticking: the person may read long passages of the book without even hearing the clock but hears the ticking clock immediately after putting the book down. When listening to the heart, the clinician's attention is quickly drawn to the most prominent sounds, but this occurs at the expense of detecting the fainter sounds. Therefore, to avoid missing these fainter sounds or subtle splitting, the clinician should concentrate sequentially on each part of the cardiac cycle, asking the following questions at each location: (1) Is S_1 soft or loud? (2) Is S_2 split and, if so, how is it split? (3) Are there any extra sounds or murmurs during systole? and (4) Are there any extra sounds or murmurs during diastole?

G. IDENTIFYING SYSTOLE AND DIASTOLE

Because all auscultatory findings are characterized by their timing, distinguishing systole from diastole accurately is essential. Three principles help the clinician to distinguish these events.

1. SYSTOLE IS SHORTER THAN DIASTOLE

If the heart rate is normal or slow, systole can be easily distinguished from diastole because systole is much shorter. Therefore the normal cadence of the heart tones is as follows:

lub dup   lub dup   lub dup   lub dup

(*lub* is S_1 and *dup* is S_2). However, when the heart rate accelerates, diastole shortens and, at a rate of 100 or more, the cadence of S_1 and S_2 resembles the following tic toc rhythm:

lub dup lub dup lub dup lub dup lub dup lub dup

In these patients, other techniques are necessary to distinguish systole from diastole.

2. CHARACTERISTICS OF THE FIRST AND SECOND HEART SOUNDS

At the second left intercostal space, S_2 is generally louder, shorter, and sharper than S_1 (S_2 has more high-frequency energy than S_1, which is why *dup*, a snappier sound than *lub*, is used to characterize S_2). If the timing of extra heart sounds and murmurs is confusing at the lower sternal edge or apex (as it often is in patients with fast heart rhythms), the clinician can return the stethoscope to the second left intercostal space, identify S_2 by its louder and sharper sound, and then inch slowly back to the area of interest, keeping track of S_2 along the way.

3. CAROTID IMPULSE

The palpable impulse from the carotid usually occurs just after S_1, which the clinician detects by simultaneously listening to the heart tones and palpating the carotid artery. However, in elderly patients with tachycardia this rule is sometimes misleading because the carotid impulse seems to fall closer to S_2, although even in these patients the carotid impulse still falls between S_1 and S_2.

The references for this chapter can be found on www.expertconsult.com.

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